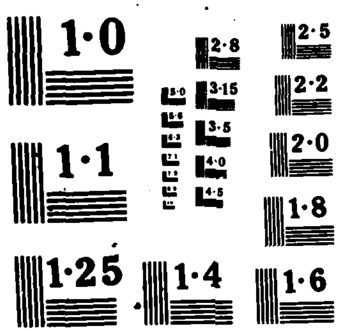
AD-A168 448 THE 8 M X 6 M LOW SPEED WIND TUNNEL AT THE CHINESE AERODYNAMIC RESEARCH A. (U) FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OH M WANG ET AL 30 MAY 86 1/1

UNCLASSIFIED FTD-ID(RS)T-0257-86 F/G 14/2 NL



NATIONAL BUREAU OF S
MICROCOPY RESOLUT TEST

FTD-ID(RS)T-0257-86

FOREIGN TECHNOLOGY DIVISION

THE 8 M X 6 M LOW SPEED WIND TUNNEL AT THE CHINESE AERODYNAMIC RESEARCH AND DEVELOPMENT CENTER

by

Wang Maoxum and Pan Ruikang

Approved for public release;
Distribution unlimited.

HUMAN TRANSLATION

FTD-ID(RS)T-0257-86 30 May 1986

MICROFICHE NR: FTD-86-C-001889

THE 8 M X 6 M LOW SPEED WIND TUNNEL AT THE CHINESE AERODYNAMIC RESEARCH AND DEVELOPMENT CENTER

By: Wang Maoxum and Pan Ruikang

English pages: 11

Source: Guoji Hangkong, Nr. 10 (Nr. 260), October 1984, pp. Inside Front Cover; 2-4

Country of origin: China
Translated by: FLS, INC.
F33657-85-D-2079
Requester: FTD/TQTA

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

Accesion For		
NTIS CRA&I	☑	
DTIC TAB	☐	
Unannounced	☐	
Justification		
By		
Distribution/		
Availability Codes		
Dist	Avail and/or Special	
A-1		

THE 8 M X 6 M LOW SPEED WIND TUNNEL AT THE CHINESE AERODYNAMIC RESEARCH AND DEVELOPMENT CENTER

Wang Maoxum and Pan Ruikang

Chinese Aerodynamic Research and Development Center

The 8 m x 6 m low speed wind tunnel at the Chinese Aerodynamic Research and Development Center (CARDC) is a large scale, double experimental section wind tunnel solely designed and built ~~by our~~ country. It is primarily used for experiments in the aerodynamic characteristics of airplanes and other aircraft; in ground wind load of guided missiles, and space vehicles; in large attack angle of airplanes and guided missiles; in large prototypes; in aerodynamics of helicopters and ~~VSDT~~ (Vertical/Short ~~Distance~~ Takeoff) ~~airplanes~~ aircraft; and in industrial aerodynamics (e.g., architecture, bridges, fans and automobiles).

The dynamic adjustments for this wind tunnel were completed in 1978, followed by flow field calibration and standard prototype tests. The automation of its standard experimental test systems were realized after having been in operation and conducting prototype aerodynamic experiments for nearly five years. At the end of 1983, it passed ~~the~~ national certification (at the end of 1983) and was officially released for use.

Overview of the Wind Tunnel

The 8 m x 6 m wind tunnel is an open-circuit, closed double experimental section in series, large scale low speed wind tunnel. Its entire length is 237 m with a maximum width of 40 m and a maximum height of 20.5 m. It consists of air intake assembly, stabilization section, first convergence section, first experimental section, second experimental section, first divergence section, fan section, second divergence section, and air exhaust assembly. See Fig. 1. For the inside view of the experimental section, see the figure on the second cover page. Removable doors are installed on the top wall of each experimental section. A turntable capable of turning 360° is installed at the center of the bottom wall. There are numerous observation windows on the side walls and top wall. The characteristic parameters of the two experimental sections are given in Table 1. The first experimental section is primarily used for conducting low speed tests of helicopters and VSDT airplanes and experimental studies on industrial aerodynamics. When the wind tunnel was designed, the flow field quality requirements were set low. This is acceptable as long as the wind tunnel satisfies the needs of experiments. The second experiment section of this wind tunnel is the primary working section. Its flow field quality met the design indexes and the nationally implemented standard indexes for a low speed wind tunnel. See Table 2. Calibration tests using our country's standard model for low speed wind tunnel pressure measurement had been conducted. The accuracy of the experiment results is presented in Table 3. The experiment velocity pressure was 287 kg/m^2 and experiment Reynold's Number was 3.9×10^6. Table 4 shows the test accuracy of both longitudinal and latitudinal pressure for the standard model DBM-01 and the aerodynamic characteristics of the measured results.

Table 1. Primary characteristic parameters of both experimental sections

	First experimental section	Second experimental section
Width x Height x Length	12m x 16m x 25m	8m x 6m x 15m
Maximum wind speed in empty wind tunnel	25m/sec	100m/sec
Minimum steady wind speed	1.75m/sec	7m/sec
Test wind speed of model	$5 \sim 21$m/sec	$20 \sim 85$m/sec
Model section length	$x < 16$m	$3\text{m} < x < 12\text{m}$

Table 2. Flow field characteristics of the second experimental section

Stability of gas flow		<0.5
Axial static pressure gradient dCp/dx (1 m)	without floor	-0.0003
	with floor	-0.003
Dynamic pressure field		$\mu \leqslant 0.5\%$
Directional field		$d(\beta) \leqslant 0.5^{\circ}$
Degree of turbulence		$\varepsilon = 0.1\%$
Temperature increase		$-2^{\circ}C \leqslant \Delta t < 0^{\circ}C$

Key: (1) In Celebration of the 35th Anniversary of National Day

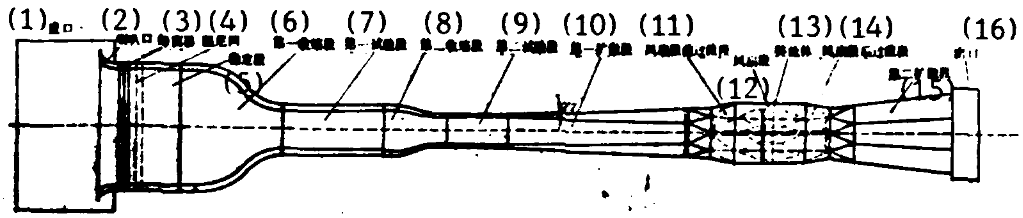


Fig. 1. Configuration diagram of the CARDC 8m x 6m low speed wind tunnel
Key: (1) Entrance; (2) Bell-shaped intake; (3) Beehive flow regulator; (4) filter; (5) stabilization section; (6) First convergence section; (7) First experimental section; (8) Second convergence section; (9) Second experimental section; (10) First divergence section; (11) pre-fan transition section; (12) Fan section; (13) Flow regulator; (14) post-fan transition section; (15) Second divergence section; (16) Exit.

Table 3. Degree of accuracy of pressure measurement at small angle for the DBM-01 standard model

(1)	均方根偏差	σc_L	σc_D	σc_m	σc_y	σc_l	σc_n
(2)	8米×6米 风洞试验值	0.001	0.0005	0.0003	0.0005	0.0003	0.0002

Key: (1) Root mean square deviation; (2) 8m x 6m wind tunnel experiment values.

Table 4. Comparison between aerodynamic characteristic data for the entire DBM-01 standard model

	C_{L_α}	α_0	C_{D_0}	$C_{m_{C_L}}$	C_{m_0}	C_{y_β}	C_{n_β}	C_{l_β}
(1) 8米×6米风洞值	0.065	-0.2	0.011	-0.064	-0.005	-0.0098	-0.0042	-0.00105
(2) 美国艾姆斯12英尺风洞值	0.055	-0.2	0.011	0.064	-0.006	-0.0104	-0.0046	-0.0011

Key: (1) 8m x 6m wind tunnel values; (2) The United States Elms 12 ft wind tunnel values.

The fan section housing is located between the first and second divergence sections and it consists of three circular passages arranged in a clover-shaped form. The three fans are installed inside the circular passages. Each fan is driven by a DC electric motor (each motor pulls 2600 KVA). See Fig. 2. The electric motor is powered by a high efficiency silicon rheostat, and its maximum speed is 480 rpm. Each fan has a diameter of 7 m and consists of 15 blades which are made of glass. A steady state rpm control system and a velocity pressure automatic control system with a high degree of accuracy are adopted to condition the motor rpm and, consequently, stabilize wind speed in the experiment section.

The wind tunnel is equipped with a standard six-component balance. It is composed of a pressure measuring element, a prototype support and an angle changing mechanism. The pressure measuring balance uses a strain balance element (see figure on second cover page). The balance is equipped with a cartridge type, rod type, ring type and combination type balance element with variable measurement spans for standard or special experiments.

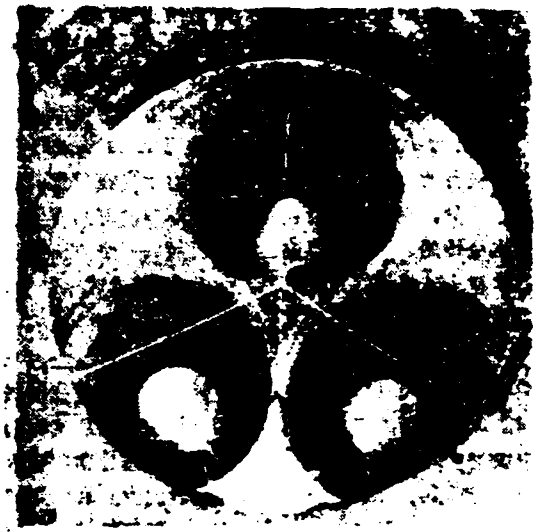


Fig. 2. "Clover-shaped" fan section

The cited wind tunnel is equipped with many scanning valves and a pressure sensor of variable measurement spans.

In order to conduct jet flow experiments, the wind tunnel is also equipped with air compressor system.

See figure on the second cover page for the view of the wind tunnel control room. The controls for the dynamic control system, prototype angle control system, air compression adjustment system for jet flow experiments, floor hydraulic control system for closing and opening the wind tunnel doors, elevation tests, etc. are conducted in the control room.

The cited wind tunnel is equipped with a computer, low and medium speed monitoring assemblies, and various computer peripheral devices to form an automatic data gathering and processing system. Real time processing of experimental data are conducted to obtain experiment results and curves.

Functionality of the Wind Tunnel

Over the past five years since 1978, many experiments had been conducted using the cited wind tunnel. They included aerodynamic experiments for strategic and tactic guided missiles, aircraft and civilian industrial applications. In the meantime, it had also been actively involved in the research of new experimental technologies; for example, large attack angle experiments, flow conditions monitoring technology, various static/dynamic tests for parachute, automobile wind tunnel tests, etc. To assemble and perfect the testing equipment has been an ongoing process.

Figures 3, 4 and 5 show the simulation capability of the cited wind tunnel in an airplane's experimental Reynold's Number, helicopter's advance ratio and propeller hub load, respectively. The advantages of using the cited wind tunnel to conduct experiments are: (1) large scale models can be selected thereby increasing the Reynold's Number and more realistically simulating the aerodynamic profile, surface protrusions, rudder surface slots, , etc. of aircraft; the accuracy of the experiment is raised, (2) large experimental Reynold's Number, (3) wider experimental speed range.

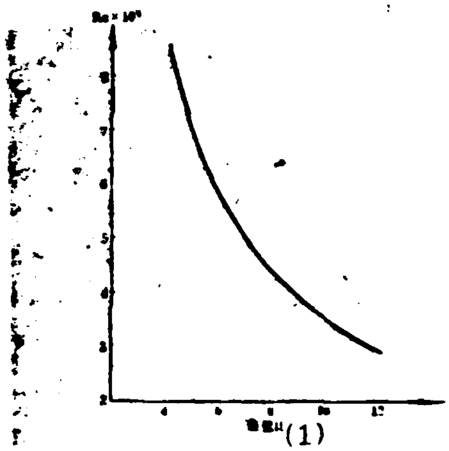


Fig. 3. At a wind speed of 85 m/sec, the experimental Reynold's Number which was reached for airplanes with various aspect ratios.
Key: (1) Aspect ratio.

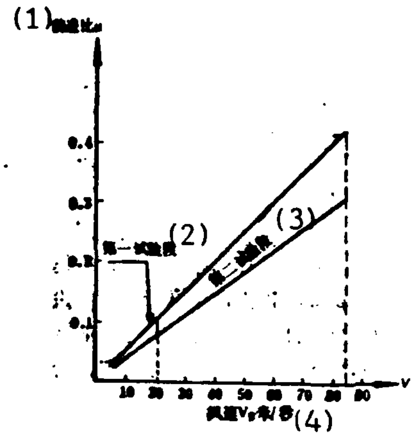


Fig. 4. Simulation capability of advance ratio
Key: (1) advance ratio; (2) First experimental section; (3) Second experimental section; (4) Wind speed V_o, m/sec.

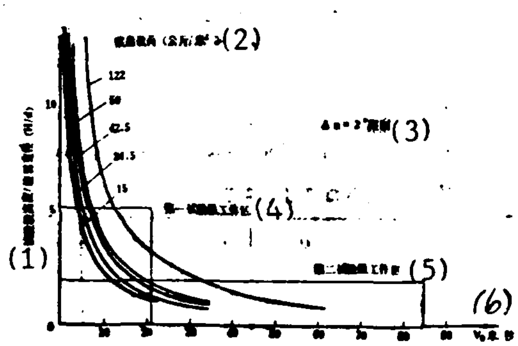


Fig. 5. Simulation capability of propeller hub load
Key: (1) Height of experimental section/propeller diameter (H/d); (2) Propeller hub load (kg/m^2); (3) limit; (4) First experimental section working region; (5) Second experimental section working region; (6) V_o m/sec.

Figure 6 shows the ground effect experiments for DBM-01 model in the cited wind tunnel. The second cover page also gives separate photographs of light-weight and adjustable wing airplanes undergoing a whole plane experiment in the cited wind tunnel.

Fig. 6. Ground effect experiment for the DBM-01 standard model

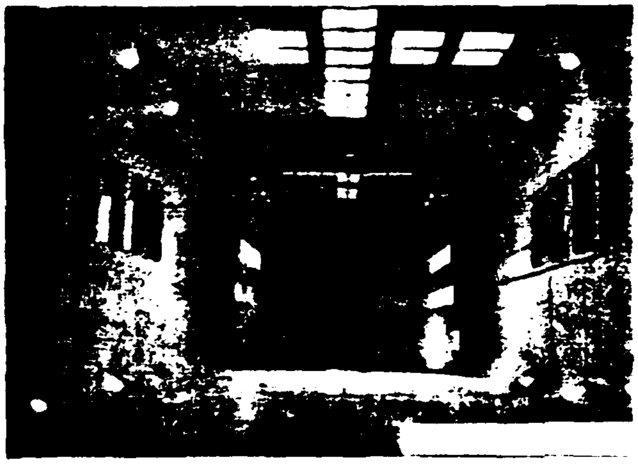
The key to the experimental technologies of aircraft with a large attack angle lies in the proper handling of problems such as interference by the fuselage frame and tunnel wall modification for separation flow. It is more difficult to handle in the case of a small wind tunnel. However, with a wind tunnel of 8 m x 6 m in dimension, it can not only guarantee fairly a large Reynold's Number, but also reduce interference of the tunnel wall, and thus satisfactory experiment results can be obtained. Presently, the cited wind tunnel adopts a tail support large attack angle experimental device to reach an attack angle of 110°.

To conduct experiments of small scale models in a large wind tunnel is one of the important approaches to studying tunnel wall interference. When comparing the results of tests conducted in a 3 m class wind tunnel with those from tests conducted in an 8 m x 6 m wind tunnel for models with the same scale, the lift curves obtained from the small wind tunnel have larger slopes. Experiments of tail support pressure measurement have also been conducted in the 8 m x x 6 m wind tunnel, and it has been instrumental to the accuracy of experimental results for pressure measurement.

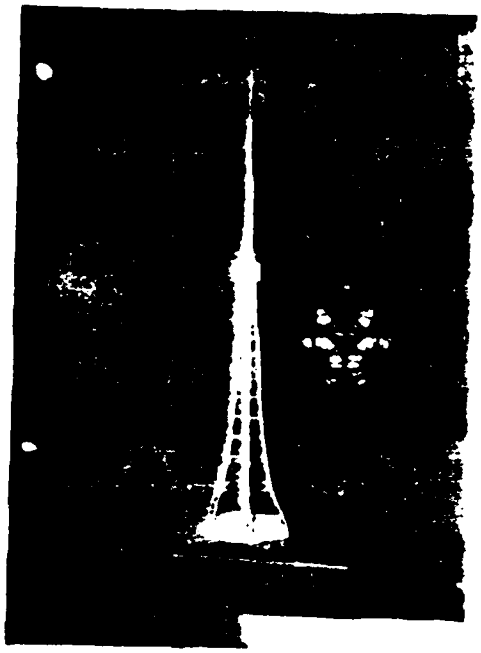
In recent years, the 8 m x 6 m wind tunnel has been used to conduct numerous experiments in areas such as wind mechanics, building, tower, automobile, radar antenna of long range shipping fleet, athletic equipment, high voltage power line, etc. Especially, better effects were obtained using this wind tunnel to conduct tests of various life-size cars of full, medium and small sizes, and it has been equipped with a combined strain balance for the exclusive use of automobile tests. Government ministries in charge of the automobile industry, as well as designers, have begun to regard the automobile wind tunnel test as an important procedure in new vehicle model design and model finalization. Figure 7 shows a wind tunnel test of a life-size Shanghai brand sedan. The second cover page shows a wind tunnel test of a model of a television transmission tower.

Fig. 7. Life-size Shanghai brand sedan undergoing test

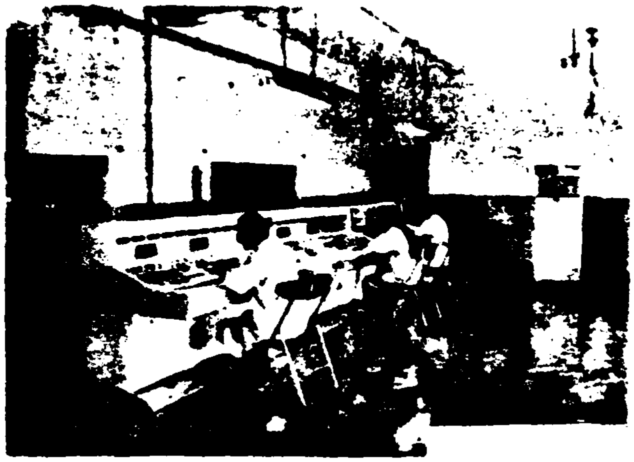
The CARDC continues to improve and perfect the 8 m x 6 m low speed wind tunnel in order to make it perform with higher experimental accuracy and efficiency.



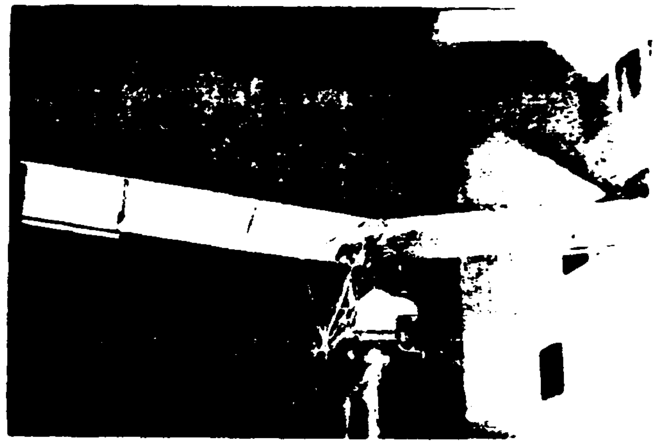
Interior view of wind tunnel's 8 m x 6 m test section.



Television tower model undergoes wind load testing in wind tunnel.

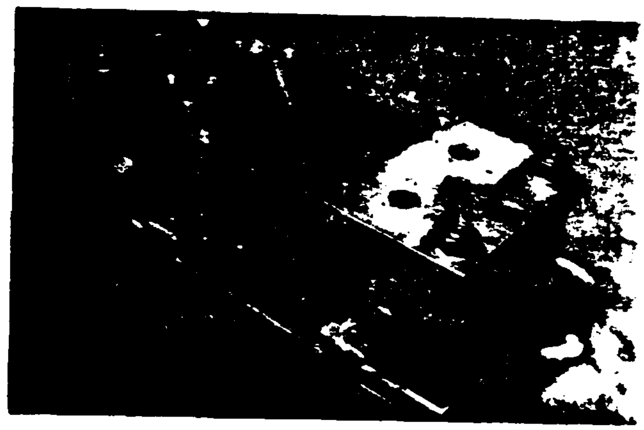


Wind tunnel control room.



Ultralight aircraft undergoes full-scale testing in wind tunnel

Parasol wing aircraft undergoes full-scale testing in wind tunnel.



Typical strain balance unit used in wind tunnel.

END
DTIC
7-86